



Optimizing the phytoextraction potential of *Eleusine indica* L. Geartn in Lead (Pb) contaminated soil

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ABSTRACT

Optimizing the phytoextraction potential of *Eleusine indica* was investigated at three levels of Pb pollution treatments (50 ppm, 100 ppm, 200ppm) and a control in a completely randomized design. Each treatment and the control were replicated thrice and allowed for 12 weeks under natural environmental conditions, one stand each of the test plant were transplanted into the experimental units. Statistical analyses of results showed morphological changes - plant shoot F-value (2.87) is lower than critical value (3.14), plant root F-value (98.9) is higher than critical value (5.64), plant heights F-value (2.7) is lower than the critical value (3.16). Phytoextraction potential of bioconcentration factor (BCF) and translocation factor (TF) results showed that *Eleusine indica*, extracted substantial concentration of Pb in the above plant biomass (shoot): which are 4.9, 19.35, and 15.1 mg/kg and root: 12.68, 82.3 and 82.25 mg/kg at 50 ppm, 100 ppm and 200 ppm respectively. Levels of Pb absorbed in the roots and shoots after 12 weeks showed that more bioavailable pool of Pb was not translocated from the roots to shoots. The result showed that the plant have a low phytoextraction potential.

1. INTRODUCTION

With the industrialization and urbanization of developing counties and the increasing demands of mankind, the consumption of lead has been growing enormously. As a result, pollution by lead has become an increasing serious issue, which has raised public awareness, unlike organic pollutants, which can be entirely, or partly degraded by the action of various microorganisms or detoxified by the action of plants, lead is nonbiodegradable. Pollution by lead therefore represents a long-term

threat for the environment and human health, not only in industrial and non-industrial areas, Contamination or pollution is a 21st century threat of the environment globally [1], These pollutants threatening the world are in different forms and compounds such as combustible substance, heavy metals, explosives, hazardous waste and petroleum products [2].

Soils may become contaminated by the accumulation of heavy metals and metalloids

through emissions from the rapidly expanding industrial activities, mine tailings, disposal of high metal wastes, lead gasoline and paints, wastewater irrigation, coal combustion residues. spillage of petrochemicals, and atmospheric deposition [3] and [4]. The major component of inorganic components are heavy Metals, as they present a different problem than organic contaminants. Soil microorganisms can degrade organic contaminants, but metals need immobilization or physical removal [5]. Thus lead renders soil unsuitable for plant growth and destroy the biodiversity. Though several regulatory steps have been implemented to reduce or restrict the release of lead pollutants in the soil, they are not sufficient for checking the contamination.

2.0 MATERIALS AND METHOD

2.1 Sample Collection

This research was carried out in a polythene bag at the Centre for Ecological Studies, University Park. University of Port Harcourt, Nigeria. The soil sample used for this study was collected from a fallow land at Rumuji Town, Emohua Local Government Area of Rivers State at a depth of 0-20cm. This area has no record of lead contamination incident. This soil was later analyzed for its physico-chemical properties which served as baseline for later analyses.

Sprouting root and shoot i.e, young plants of *Eleusine indica* were collected from a pasture area using hand trowel to uproot them at depth of 0-15cm and 15-30cm within University Park, University of Port Harcourt. The roots and shoots were cut to 5cm using a knife. The soil sample were air-dried and later homogenized thoroughly.

2.2 Experimental Design and Treatment

The setup was a complete randomized design and the treatments were replicated three times. The experimental bag (polythene) were filled with 5 kg lead contaminated soil of different

concentrations of Pb contaminants, Polluted with 0ml (which served as a control) 50ml, 100ml, 150 ml, and 200 ml. The roots and shoots (3 stand per bag, which were all cut to 5cm were planted in each bag. The plants were irrigated with 200 ml (per bag) of water daily and sampling of the plants to monitor lead uptake and soil for residual metal contents were done 2weeks after planting.

2.3 Soil Contamination with Lead (Pb)

The lead was added to the soil as lead nitrate, $Pb(NO_3)_2$, and 1.58g of $Pb(NO_3)_2$ was dissolved in 10L of distilled water which is equal to 1000ppm as the stock solutions, different concentrations were then measured from the stock solutions into a 100ml capacity measuring cylinder and made up to the mark to give 50ppm, 100ppm,200ppm metal pollution concentrations and Oppm as the control. The soils were contaminated with different concentrations of lead in a 5kg soil.

2.4 Data Collection

At 12 weeks after planting, all the plants were harvested separately according to soil treatment. separated into two compartments, namely roots and shoot parts (seed, stem and leaves). The 3 replicates of each treatment were pooled together to give composite sample of each treatment and the control. The plants were washed in water to eliminate soil particles, dirt, possible parasites or their eggs, and finally with deionized water. Each subsample was oven-dried at 70°C for 24 hours. Acid digestion method of [6] were used for the digestion of grinded plant samples. 1g each of this sample were weighed into 50ml capacity beaker followed by addition of 10 ml mixture of analytical grade acids: HNO_3 , H_2SO_4 , $HClO_4$ in the ratio 1:1:1. The beakers containing the samples were covered with watch glasses and left overnight. The digestion were carried out at temperature of 70°C until about 4ml were left in the beaker. Then, a further 10 ml of the mixture of acids were added. This mixture were

allowed to evaporate to a volume of about 4 ml. After cooling, the solutions were filtered to remove small quantities of waxy solids and made up to a final volume of 50 ml with distilled water. Lead concentrations were determined using Atomic Absorption spectrophotometer (AAS)

2.5 Determination of Bioconcentration and Translocation Factors

Bioconcentration factor (BCF) and Translocation factor (TF) were calculated using the formula of [7].

$$BCF = \frac{\text{average metal concentration in the whole plant} (\frac{mg}{kg})}{\text{metal concentration in the soil} (\frac{mg}{kg})}$$

$$TF = \frac{\text{Total metal concentration in plant shoot}}{\text{Total metal concentration in plant root}}$$

2.6 Statistical Analysis of Data

Data collected were subjected to a one-way analysis of variance [8].

3 RESULTS AND DISCUSSION

Table 3.1: Baseline Physico-chemical properties of soil

Parameters/ Treatments	pH	Total Organic Matter (%)	Conductivity (μ S/cm)
Control	6.47	5.3	45
50ppm	6.31	6.70	70
100ppm	6.20	7.2	92
200ppm	6.04	7.2	157

The results from the Physiochemical properties of the soil after 12 weeks of phytoextraction shows that the Soil pH is generally within the range for Soil establishment by FEPA (A guideline of standard for industrial effluents and waste management in Nigeria 1991). The pH level of the

control was 6.47 being the highest, while 200ppm was the lowest with 6.04. The high value of pH in the contaminated bags may be due to presence of Pb contamination in the Soil. Soil pH played an important role in the control of organic matter content [9].

The presence of lead in the contaminated soil including that of the control could be as a result of pollution from industrial activities around where the soils were collected. Indication from the physiochemical analysis shows that the presence of lead (Pb) in the soil affected both the soil and plant in a number of ways.

The soil conductivity of the control had the lowest value with 45 μ S/cm while 200ppm had the highest value with 157 μ S/cm.

The soil organic matter of the control had the lowest value with 5.3%, while 100ppm and 200ppm both had the highest value.

Table 3.2 Concentration of lead (Pb) in soil from control and contaminated samples

Samples	Mg/Kg
Control	10.75
50ppm	17.33
100ppm	65.15
200ppm	92.85

The Lead concentration recorded after plant harvest were less than the concentration introduced to the soil Table 3.2. Since the computed F-value of 13.8 was higher than the critical value (4.38), it can be concluded that there is significant difference between the mean yields at the different treatment levels.

Table 3.3: Concentration of Lead (Pb) after 12 weeks for shoot and root

Treatments /Control	Shoot (Mg/Kg)	Root (Mg/Kg)
Control	16.2	52.1
50ppm	4.9	12.7
100ppm	19.4	82.3
200ppm	15.1	82.3

The concentration of Lead (Pb) after 12 weeks for shoot and root Table 3.3. The results indicated that *Eleusine indica* accumulated the Lead. The slight difference in Morphological analysis between control and different ppm in different parameters ranging from height, number of leaves, etc. indicated that the contamination of lead did not affect the plant negatively, the plant grew safely in the lead contaminated soil. this agrees with the study done [10] that found that unlike many other heavy metals such as cadmium, copper, and nickel, moderate concentrations of lead in the soil (<500ppm) have no noticeable harmful effect on plant growth.

4. CONCLUSION

Cleaning contaminated soils and waters with the use of plants of different species known as phytoextraction has gained increasing interest since the last decade till now, as an emerging cheaper means for clean up processes, It is clear that phytoextraction has benefits to restore balance to a contaminated environment, but it is important to proceed with caution and due procedures. From this research, it has shown that phytocxtraction is among the best ways to go, since it is cost effective. This study indicated that *E. indica* accumulated lead (Pb) but translocated minimal amount to its tissues, therefore it is a good accumulator for phytoextraction though a bad translocator (excluder).

Conflict of Interest Declaration

The author(s) declare no conflict of interest

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